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A. Work Plans

1. Should a workplan be submitted for every RECAP assessment?

No. Workplans are only required for MO-3 assessments. However, for more complex MO-2 assessments, it is recommended that a workplan be submitted prior to conducting the MO-2 assessment. The more detailed the workplan the more effective it will be as a tool for ensuring that the RECAP submittal addresses site management issues in a manner that is acceptable to the Department and in compliance with RECAP.

B. Site Investigation

1. When conducting a site investigation, which soil samples need to be submitted to the lab for chemical analyses?

Soil samples that should be submitted to the lab for chemical analysis include: 1) the soil sample exhibiting the highest OVM reading as a result of a field headspace analysis; 2) the soil sample at the groundwater interface, and 3) the soil sample at the total depth of the boring. Note that the sample with the highest OVM reading may also be the sample collected at the groundwater interface or at the total depth of the boring.

The horizontal and vertical extent of the impact should be delineated and the impacted soils should be sufficiently characterized to assess the two soil classifications identified under the RECAP: surface soil (0 - 15') soil and subsurface soil (> 15' bgs). Please note that this does not necessarily mean that every soil classification horizon shall have a chemical analysis done.

2. From which interval should soil physical characteristic samples be collected?

Soil physical characteristic (i.e., soil organic carbon, total porosity, dry bulk density, etc) samples should be collected from an unimpacted area of the permeable zone in which fate and transport will be evaluated.

3. Should soil physical characteristic samples be collected in every boring?

It is not necessary to collect soil physical characteristic (i.e., soil organic carbon, total porosity, dry bulk density, etc) samples from every borehole. Soil physical characteristic samples should be collected from a sufficient number of borings to ensure that the permeable zone being evaluated is properly characterized. The degree of heterogeneity of the permeable zone will determine the number of soil physical characteristic samples to be collected.

4. Can a hand auger be used to collect soil for organic matter testing?

Some geotechnical soil samples are collected as undisturbed samples to avoid sample bias. However, for organic matter testing, it is acceptable to collect the soil with a hand auger.

5. For sites that were investigated but did not collect soil for organic matter testing, is it necessary to resample for this parameter?

No, you may use the default foc value of 0.006 or you may sample the soil to derive a site-specific value for foc.

6. The state background level for arsenic in soil was 7 mg/kg under RECAP 2000. In the new document (RECAP 2003), the background arsenic level for soil is given as 12 mg/kg in Tables 1 (Soil_{SSni} and Soil_{SSi}) and 2 (Soil_{ni} and Soil_i). Why did the background level change?

Under RECAP 2000, the arithmetic mean was used to represent the background concentration regardless of the number of samples comprising the background data set. Under RECAP 2003, if the background data set contains < 7 data points then the arithmetic mean is used as the background concentration and if the background data set contains > 8 sample points, then the arithmetic mean plus one standard deviation may be used as the background concentration (refer to Section 2.13 for further guidelines). The data set used to calculate the state background arsenic concentration in soil consists of 83 data points (*Total Metal Concentrations in Louisiana Surface Soils*, LSU Cooperative Extension Service, 1990). Therefore, to be consistent with RECAP 2003, the state background concentration was recalculated to represent the arithmetic mean plus one standard deviation:

$$\mu = 7.0 \text{ mg/kg}; \sigma = 4.5; n = 83$$

$$\text{Background arsenic concentration} = 7 + 4.5 = 11.5 \text{ mg/kg} = 12 \text{ mg/kg.}$$

7. May soil-gas sampling be used to evaluate vapor intrusion to an enclosed structure for soil and groundwater (Soil_{es} and GW_{es} pathways)?

Yes, soil gas samples may be collected to evaluate the potential for vapor intrusion into enclosed structures. Soil gas sampling should follow the model screening procedure when determining if a volatile compound is a concern at a site. If vapor intrusion associated with subsurface contamination appears to be a concern based on a comparison of soil and/or groundwater data to enclosed structure standards present in RECAP Tables 2 or 3 or site-specific standards developed using Appendix H, soil gas samples may be collected to evaluate site conditions.

The principal objective of soil gas sampling is to obtain an upper-bound representation of the source concentration beneath the structure that will allow for a conservative estimation of the potential exposure and health risk associated with vapor intrusion. To achieve this objective, baseline samples must be collected under conditions expected to give rise to maximum soil gas concentrations. Such site-specific conditions that may influence soil gas concentrations include meteorological conditions (temperature, barometric pressure, and precipitation), hydrogeological conditions (periods of high groundwater levels), and gravitational effects (tides). These conditions shall be noted and discussed in the submittal.

Sample Collection:

Sufficient samples are to be collected to estimate the COC concentrations based on spatial and temporal scales. Dependent on site-specific conditions, multiple sampling events may be necessary to adequately characterize the upper bound soil gas COC concentration contributing to indoor air exposure. A work plan addressing the following items shall be submitted for approval before soil gas sampling is performed at a site. Soil vapor sampling issues specific to UST sites are discussed at the end of this section.

(a) Soil gas samples may be taken immediately adjacent to (perimeter sample) or from beneath the slab in the area of highest subsurface contamination. In general, both perimeter and sub-slab soil gas samples should be collected as close as possible to exterior walls. The depth and volume of the soil gas sample shall be adequate to prevent the leakage of atmospheric air into the sample. Perimeter samples should be collected at multiple depths to provide a vertical soil gas profile. A minimum of two intervals should be sampled, e.g., five feet and three feet, four feet and two feet, etc., based on site geology and peak water table elevation. When collecting sub-slab samples, at least one additional sample shall be collected from an interior location near the center of the slab. Samples taken from beneath the slab may be obtained by drilling directly through the slab or by angle-drilling and should be collected within twelve inches of the bottom of the slab in the most permeable material present in the zone. If sampling directly beneath the slab is not possible, sufficient samples shall be collected adjacent to the structure to allow for estimation of the COC concentration in the soil and/or groundwater beneath the structure based on spatial and temporal scales. For sites with a seasonally high water

table less than ten feet below ground surface, soil gas sampling shall coincide with seasonal peak water table elevations.

- (b) Gas probe installation methods may include hand equipment (hand auger, hammer drill, etc.), hydraulically advance probes, or other approved equipment. Sampling points should consist of small diameter tubing extending from the sampling zone to the surface equipped with an appropriate screen (sampling tip or other approved material). Use of small diameter (e.g. 1/8 inch) tubing is encouraged to reduce purge volume and prevent leakage/breakthrough. Materials of construction shall not adversely affect sample integrity and may include such materials as stainless steel, nylon, or Teflon. Sampling points shall be provided with an annular seal to prevent vertical contaminant migration, infiltration, and atmospheric intrusion during sampling.
- (c) Sample collection shall be by an active whole-air sampling method. Unless otherwise approved, a minimum of three dead volumes shall be purged prior to sample collection. Samples should be collected in low volume canisters (generally < 1L) or other method-specific container. Samples for semi-volatile analysis may be collected on a polyurethane foam (PUF) plug. Sample collection by other methods shall receive Department approval.
- (d) Leakage of atmospheric air into the samples shall be checked using an appropriate tracer gas to determine sample reliability.
- (e) Soil classifications shall be performed for all soil gas samples and shall describe the soil type at each sampling location.
- (f) Perimeter sampling points shall include the most permeable unsaturated zone in accordance with the previously described requirements.**
- (g) Flow rates into the Summa canister shall be less than 200 mL/min.
- (h) Samples shall be analyzed within 48 hours.
- (i) Samples shall not be chilled during storage.
- (j) Vertical soil profiles used for the purpose of documenting site-specific bioattenuation shall include, at a minimum: 1) samples obtained from two locations at a depth between 1 to 5 ft bgs; and 2) measurements of oxygen, methane, and carbon dioxide.

Soil Gas Sampling Issues Specific to UST Sites:

Due to business-related activities, equipment, and space limitations, sub-slab soil vapor sampling may not be practical or possible at typical UST sites. As an alternative, LDEQ will consider the use of soil vapor samples collected immediately adjacent to the structure to determine if vapors from contaminated subsurface soil or groundwater are adversely impacting indoor air quality. The following items shall be addressed in all non-sub-slab soil-vapor sampling work plans submitted for UST sites:

- (a) Selection of sampling points – the number and locations of sampling points shall be capable of providing information considered to be representative of sub-slab soil vapor conditions and address the potential for vapor entry into all parts of the structure exposed to subsurface contamination.
- (b) Construction of sampling points – all sampling points shall be: 1) installed in a manner that does not adversely affect the collection of representative samples; 2) constructed of materials that will not adversely impact sample integrity; 3) sealed with an appropriate material to prevent vertical vapor

migration along the annulus; and 4) capable of providing a vertical profile of soil vapor (e.g., sample locations shall include multiple vapor probes screened at different intervals below ground surface).

- (c) Sample collection – sample collection shall meet the following requirements: 1) the sampling protocol shall ensure that all sampling equipment is contaminant-free; 2) sampling probes shall be purged of a minimum of three volumes while exercising care to avoid excessive purging; 3) soil vapor sample volumes shall be limited to ensure a representative sample of the zone of interest (generally < 500 cc); 4) the sampling protocol shall include a tracer compound to verify annular seal integrity; and 5) vapor samples shall conform to RECAP stipulated QA/QC protocol for preservation, shipping, and handling.
- (d) Sample analysis – analytical procedures shall conform to RECAP requirements for applicability and detection limits. In addition to the petroleum-related constituents of concern identified from Table D-1 of Appendix D of RECAP, the analyte list should include oxygen, carbon dioxide, and methane to allow for the evaluation of bioattenuation under site-specific conditions.

Quality Assurance/Quality Control protocol:

- (a) See RECAP Section 2.4
- (b) Collect data on ambient conditions that could influence soil gas results.

Analytical Methods:

Volatile samples may be analyzed using either: 1) EPA Reference Method TO-15; or 2) EPA Method 8260 if appropriate for the COC (i.e., method SQL is less than the level of concern). Constituents collected on a PUF plug shall be analyzed using EPA Method TO-10. The use of any other analytical procedure shall be justified in the work plan.

Application of Soil Gas Data:

1. Compare the maximum detected concentration and the 95%UCL-AM concentration for the soil gas data and identify the lower of these two values as the soil gas AOIC for the evaluation of the vapor intrusion pathway.
2. Identify the soil gas standard from the attached table (Table H5*alpha).
3. Compare the soil gas AOIC to the soil gas standard:

If the AOIC for all of the COC are less than or equal to soil gas standards, then typically no further action is required for the vapor intrusion pathway.

If the AOIC for a COC is greater than the soil gas standard, then the submitter shall further evaluate the vapor intrusion pathway or remediate the soil and/or groundwater to a COC concentration that will not result in an unacceptable COC concentration in indoor air. To further evaluate the vapor intrusion pathway, the Submitter may conduct indoor air sampling at the AOI and compare the indoor air AOIC to the C_a in accordance with Appendix B and Sections H1.1.3.5 and H2.3 of Appendix H. It should be noted that Departmental approval is required prior to conducting indoor air sampling.

Note: The soil gas standards presented in the attached table represent the acceptable COC concentrations in soil gas that will not result in unacceptable COC concentrations in indoor air. These values were derived by adjusting the acceptable indoor air concentrations (C_a) (Table H-5 of Appendix

H of RECAP 2003) to account for attenuation (reduction) of the COC concentration in soil gas associated with migration from the subsurface to the interior of the enclosed structure. In accordance with EPA guidance/recommendations (*Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*, EPA 2002; EPA Region VI Vapor Attenuation Workshop April 2004) a default alpha factor of 0.1 (i.e., attenuation factor of 10) was applied. Based on literature recommendations (Blayne Hartman, Ph.D.) and EPA recommendations (EPA Region VI Vapor Attenuation Workshop April 2004), an alpha of 100 was applied to petroleum-related constituents. If it is determined by the Department that the default alpha factor applied in Table H5*alpha is not representative of site-specific conditions, the soil gas standards presented in the Table H5*alpha may not be used for the evaluation of the vapor intrusion pathway and/or for site management decisions.

Example:

1. The concentration reported for benzene in the soil gas is 900 ug/m^3 .
2. The soil gas standard for benzene is 1200 ug/m^3 (refer to Table H5*alpha).
3. Compare the soil gas concentration to the soil gas standard:

$900 \text{ ug/m}^3 < 1200 \text{ ug/m}^3$ therefore no further evaluation of the soil vapor intrusion pathway is required for benzene

8. For volatile sources present at depths greater than 15 ft bgs, is it required that the vapor intrusion pathway (Soil_{es}, GW_{es}) be evaluated?

In general, the vapor intrusion pathway is applicable to soil and groundwater [impacted with a volatile constituent(s)] present at a depth less than or equal to 15 ft bgs and located beneath an enclosed structure. The need to evaluate the vapor intrusion pathway for soil and/or groundwater present at a depth greater than 15 ft bgs shall be determined by the Department based on site-specific conditions (COC present, nature of the release, subsurface characteristics, etc.) and the level of concern associated with the potential migration of volatile emissions from soil and/or groundwater to an enclosed structure. It is strongly recommended that you coordinate with your LDEQ remediation team leader for the evaluation of the vapor intrusion pathway.

9. In Appendix D Table D-1 methyl tertbutyl ether (MTBE), methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK) are identified as COC for gasoline and the associated footnote states "when suspected to be present". When should these constituents be included as analytes when evaluating gasoline releases?

A fuel additive(s) (MTBE, MEK, MIBK, etc) should only be identified as an analyte or COC for the evaluation of a gasoline release when it is a known, documented fact that the gasoline formulation released into the environment contained the additive. Under routine release situations such as occurs at typical UST sites, it is not necessary to include these constituents as analytes for the site investigation or as COC for the RECAP assessment.

10. The TPH-G, TPH-D, and TPH-O carbon ranges in RECAP 2003 are different from the ranges defined in RECAP 2000. Can TPH data generated using the carbon ranges in RECAP 2000 be used in RECAP assessments under the RECAP 2003 regulation or do I have to re-sample?

Yes, TPH data generated under RECAP 2000 may be used to perform a RECAP assessment under RECAP 2003. It is not necessary that an AOI be re-sampled/re-analyzed due to the RECAP 2003 revision of the TPH carbon ranges. Due to numerous comments received by the Department, the carbon ranges for the TPH mixtures (TPH-G, TPH-D, TPH-O) were revised in RECAP 2003 to be consistent with the carbon ranges defined by EPA SW846 Method 8015B.

Unless otherwise approved by the Department, an AOC/AOI currently being regulated under RECAP 2000 may continue to comply with RECAP 2000 until the current phase/task of the assessment has been completed and approved by the Department. For further guidance on the transitioning of the assessment of an AOI from RECAP 2000 to RECAP 2003, refer to the first paragraph of Section 1.0 (page 1) of RECAP 2003.

11. Jet A fuel is not listed in Table D-1 of Appendix D. What indicator compounds and/or hydrocarbon fractions should be used to evaluate a Jet A fuel release?

Jet A is a kerosene based fuel that consists of hydrocarbons in the range of C_9-C_{16} . Therefore, the hydrocarbon fractions that should be evaluated include aliphatics C_8-C_{10} , aliphatics $C_{10}-C_{12}$, aliphatics $C_{12}-C_{16}$, aromatics C_8-C_{10} , aromatics $C_{10}-C_{12}$, and aromatics $C_{12}-C_{16}$. In lieu of evaluating these hydrocarbon fractions, the hydrocarbon mixtures TPH-GRO and TPH-DRO may be used.

C. Data Issues

1. We recently had several soil samples analyzed for semivolatile constituents (SW-846 EPA 8270 with a GC/MS) and a few of the samples contained elevated concentrations. In order to perform the analysis, the lab had to dilute the samples. When they diluted the samples, the sample quantitation limit (SQL) went up. So in essence, we have some constituents that are reported non-detect but the SQL is above the RECAP standard. How should the non-detect data with elevated SQL be interpreted under RECAP?

According to the RECAP Regulation if a COC is reported as not detected and the sample quantitation limit is greater than the reference concentration for a significant number of samples or for a key sampling location, then the samples should be reanalyzed. It is recommended, that prior to submitting samples for analysis, that the Submitter consult with the lab to ensure that the SQLs for the requested analyses are sufficiently low enough (< SS or RS) to provide useful data for use in the RECAP. Sample results with SQLs above SS or RS are not useful for RECAP assessments. One of the first steps in the RECAP process is to conduct a site investigation that defines the vertical and horizontal extent of contamination. The Department encourages the Submitter to submit the site investigation data prior to performing the RECAP analysis if there is any question regarding the adequacy of the Site Investigation. If the site investigation is adequate, one option is to assume that the concentration of the sample is equal to the SQL (or 1/2 the SQL) and use this value in the calculation of the 95%UCL-AM. Other options would be to resample or to perform remediation and attain the RECAP Standard then conduct confirmatory samples to demonstrate that the RECAP Standard has been met at these sampling locations (SQLs for the confirmatory samples should not be higher than the RECAP Standards since the constituent concentrations should no longer be elevated).

2. At an AOI impacted with TPH, the reported concentrations for TPH-G and TPH-D were above the SS. Therefore, additional samples were collected from the area of greatest impact and analyzed using the fractionation method. All of the samples were ND for all of the fractions. Is it still necessary to address the TPH-G and TPH-D in the RECAP assessment?

Site management decisions should be based on the fractionation data (assuming it meets all QA/QC requirements) since this data is more specific and thus more representative of site conditions.

3. We have a site that was sampled for metals in the soil. Almost all of the samples came back with numbers slightly above the RECAP screening standard and MO-1 standard for arsenic. If a background sample is obtained from a non-contaminated region of the site to determine "normal" arsenic background levels, could this value be used to subtract out the background arsenic levels from those measured in the contaminated zone? Would one background sample suffice, or would several samples be required (the area of impact is less than 0.5 acre)?

No, there is no reason to subtract out the background arsenic levels from those measured in the contaminated zone. To determine if the arsenic is site-related, the site-specific or state background arsenic concentration should be compared to the mean AOI arsenic concentration. If the background data set consists of < 7 samples, then the arithmetic mean of the data set shall be used to represent the site-specific background concentration. If the background data set consists of > 8 samples, then the arithmetic mean plus one standard deviation shall be used to represent the site-specific background concentration (refer to Section 2.13 for further guidance). If the mean AOI arsenic concentration is greater than the site-specific or state background arsenic concentration then it should be concluded that a release has occurred/arsenic is a site-related constituent and arsenic should be included in the RECAP assessment. If the mean AOI arsenic concentration is less than or equal to the site-specific or state background arsenic concentration then it should be concluded that a release has not occurred. In the event the site-specific background concentration is less than a limiting SS or RS, then the background concentration (if approved by the Department) may be used as the SS or RS. In general, one sample is not sufficient for any sampling objective. Sample number is best determined on a case-by-case basis. Note: The state background arsenic level in soil is 12 mg/kg. This value may be used in lieu of identifying a site-specific background concentration for arsenic.

4. Are dissolved metal groundwater results admissible under RECAP?

Total metals should always be collected. In the event that the samples are turbid and it is expected that the groundwater will be classified as a GW-3, it is recommended that dissolved metals also be collected. Both the total and the dissolved values would be evaluated by the Department along with the justification as to which samples are most appropriate for the situation at hand. It is not expected that samples collected from a properly constructed and developed monitoring well would experience problems with turbidity.

5. Should data be reported on a dry-weight or a wet-weight basis?

Analytical laboratories routinely report data on a wet-weight basis. If requested, the laboratory can report the percent moisture of the sample so that the results can be converted to a dry-weight basis if desired or required. In general, exposure concentrations and hence, risk-based RS are based on wet-weight. However, the environmental fate and transport RS are based on dry weight. In general, most soils have a relatively low percent of moisture and the difference between wet-weight and dry weight concentrations is not usually significant. For soils with a high moisture content or for sediments, the weight-wet and dry weight concentrations may be significantly different. In this situation, the percent moisture should be taken into account when calculating the AOIC for comparison with the environmental fate and transport RS. Data on a wet-weight basis may be converted to a dry-weight basis as follows:

$$\text{Dry wt concentration} = \frac{\text{Wet wt concentration} \times 1 \text{ kg wet soil}}{1 \text{ kg wet soil} - (\% \text{ moisture}) \text{ kg dry soil}}$$

6. Are the results of the performance evaluation the same as the internal standards performance?

No, they are not the same. The performance evaluation samples are samples that analyzed by the laboratory in which a known amount of chemical is present in the sample and the results of the laboratory analysis are compared to the known amount of chemical to evaluate the performance of the analysis by the laboratory. The laboratory may conduct the performance evaluation themselves or a client or regulatory

agency may send performance samples to the laboratory to evaluate the laboratory for performance of the analysis. Internal standards (as referenced in the CLP guidelines) are used for the calibration and continuing calibration of the analytical equipment.

7. When validating/evaluating data, does RECAP require that “Laboratory Data Validation Functional Guidelines for Evaluating Organic Analysis” be followed to the letter?

No, to comply with RECAP, the data only has to meet the requirements listed in Section 2.4. It should be noted that, in general, the term “validation” refers to data generated under the Contract Laboratory Program (CLP). CLP data is accompanied by extensive documentation and allows for a more thorough evaluation of the data quality than data generated by other methods. It should be noted that CLP data is NOT required under RECAP but MAY be used under RECAP if desired by the Submitter.

8. What is an acceptable method for estimating the precision of the analysis?

Any replicate samples can be used to measure precision, including MS/MSD data and field duplicate data.

9. How should constituent concentrations detected between the PQL (practical quantitation limit) and the MDL (Method Detection Limit) be handled under RECAP?

Concentrations detected below the PQL but above the MDL are flagged with a J qualifier which indicates the reported concentration is estimated. The concentration is reported as estimated because the level being detected is below the calibration range, i.e., the concentration detected is below the lowest concentration on the calibration curve (PQL). There is certainty as to the identification of the chemical but uncertainty as to the reported concentration. For the purposes of risk assessment, J-qualified concentrations are used the same as positive data that do not have a J qualifier.

10. What are the recommended analytical methods (e.g., acceptable by LDEQ for RECAP) for the soil physical characteristics used in RECAP?

Undisturbed soil samples should be collected in accordance with ASTM Method D1587 using thin-walled, stainless steel Shelby tubes or other undisturbed sampling tools approved by LDEQ. Soil characteristics/geotechnical analysis that shall be required include (but may not be limited to):

- . • Organic matter (ASTM D2974 or other upon LDEQ approval)
 - . • Unified Soil Classification System (ASTM D2487)
 - . • Atterberg Limits (LL, PL, PI) (ASTM D4318)
 - . • Particle Size Analysis (ASTM D422)
 - . • Hydraulic Conductivity¹ (Constant Head) (Granular soils) (ASTM D2434)
 - . • Hydraulic Conductivity¹ (Falling Head) (Fine grained soils) (ASTM D5084)
- Additional parameters that may be necessary include:
- . • Soil pH (ASTM D4972)
 - . • Dry density (Calculated)
 - . • Moisture content (ASTM D2216)
 - . • Specific Gravity (ASTM D854)
 - . • Total Porosity (Calculated)

11. It is stated in the RECAP-FAQ that soil physical characteristic samples should be collected from an unimpacted area of the permeable zone in which fate and transport will be evaluated. Should the site-specific soil data used to calculate the VF for Soil_i and Soil_{ni} also be collected from the permeable zone?

The soil parameters for the calculation of the VF for Soil_i and Soil_{ni} and VF for groundwater should be collected from the unsaturated zone since the EF&T equations for the VF are concerned with this zone. The GW VF equation does allow for the use of site-specific data from the capillary fringe. It is possible to have different soil classifications and/or properties in the unsaturated and saturated zones.

12. What is the appropriate analytical method to be used to evaluate total petroleum hydrocarbons?

Total petroleum hydrocarbons may be evaluated under RECAP using: 1) methods that characterize gasoline, diesel, and oil range hydrocarbon mixtures: TPH-GRO (C₆-C₁₀), TPH-DRO (C₁₀-C₂₈), TPH ORO (C_{>28}); or 2) methods that produce fraction-specific TPH data (aliphatics >C₆-C₈, aliphatics >C₈-C₁₀, aliphatics >C₁₀-C₁₂, aliphatics >C₁₂-C₁₆, aliphatics >C₁₆-C₃₅, aromatics >C₈-C₁₀, aromatics >C₁₀-C₁₂, aromatics >C₁₂-C₁₆, aromatics >C₁₆-C₂₁, and aromatics >C₂₁-C₃₅). The DEQ suggested analytical methods for the hydrocarbon mixtures include: 1) SW-846 Method 8015B (modified-extraction/GC-FID); and 2) TCEQ's Method 1006 (<http://www.tnrc.state.tx.us/permitting/analysis.htm#5035>). The DEQ suggested analytical methods for the fraction-specific analyses include: 1) the Massachusetts Department of Environmental Protection's VPH/EPH Method; and 2) TCEQ's Method 1005 (<http://www.tnrc.state.tx.us/permitting/analysis.htm#5035>). The Submitter may choose which approach is used to assess an AOI.

13. What methods can be used to determine fractional organic carbon?

The following methods are acceptable for determining fractional organic carbon:

1. Heat Loss on Ignition (ASTM D2974)

- This method is used to determine the percent organic matter within soil and sediment. The ash content is determined by igniting the oven-dried sample in a muffle furnace. The substance remaining after ignition is the ash. Percent organic matter is determined by subtracting percent ash content from one hundred.
- The units are typically reported as percent organic matter. To convert to fractional organic carbon (foc), divide percent organic matter by 174.0.

2. Total Organic Carbon (SW-846 Method 9060)

- A modification of Method 9060 is used to determine organic carbon in soil and sediment. A soil or sediment sample is placed in a combustion boat and dried in a desiccator for 24 hours. The inorganic carbon from carbonates and bicarbonates is removed by acid treatment. The samples are dried in an oven and are then ready for analysis. The organic compounds are decomposed by pyrolysis in the presence of oxygen. The carbon dioxide that is formed is determined by direct non-dispersive infrared detection. The infrared detector determines the amount of carbon present in the carbon dioxide.
- The units are typically reported as TOC in mg/kg. To convert to fractional organic carbon (foc), divide TOC (mg/kg) by 1×10^6 .

$$foc = \frac{\text{Organic Matter (\%)}}{174.0}$$

$$foc = \frac{TOC \text{ (mg / kg)}}{1 \times 10^4}$$

14. We have analyzed a sample for TPH using 8015B. While the sample results indicate an exceedence of the calculated/given RS, we believe the result to be in err due to positive nontarget interferences or from a "dirty" sample. May we use a silica clean-up on the sample?

No.

While there is a possibility for positive error in the 8015B analysis caused from physical or chemical interferences due to complex sample matrix; a silica clean-up process may produce a non-quantified negative error. There is no way to determine if the clean-up process removed only the nontarget interferences, or if both sought analytes (to some unidentified quantity) as well as inferences were removed.

If positive error is suspected, further fractionation approaches to analysis (allowing for more specific, precise, and detailed sample information) are recommended. Department approved fractionation methods may be found in Appendix D of RECAP 2003.

15. The carbon ranges for TPH-GRO, TPH-DRO, and TPH-ORO in RECAP 2003 are different from the carbon ranges that were used under RECAP 2000. Can TPH data based the carbon ranges defined in RECAP 2000 be used under RECAP 2003 or is re-sampling/analysis required?

Re-sampling is **NOT** required. TPH data based on the carbon ranges defined in RECAP 2000 may be used to conduct a RECAP assessment under RECAP 2003. If additional TPH data is collected at the AOI, the TPH ranges defined by RECAP 2003 should be used. The carbon ranges for TPH-GRO (C₆₁₀), TPH-DRO (C_{10-C28}), and TPH-ORO (C_{>28}) were revised in RECAP 2003 to be consistent with the carbon ranges designated by EPA SW846 Method 8015B.

16. I have calculated a risk-based standard for a constituent that isn't listed in the RECAP Tables section. My contracted laboratory has told me their detection limits are not sufficiently low enough to meet the limiting values. May we use the laboratory's projected SQL as the RECAP Standard?

No. If the laboratory cannot meet the detection limits, than a laboratory capable of meeting limits should be sought, or the COC may be advanced to a higher management option for evaluation. If neither of the above options is feasible, than a supported calculated QL may be submitted for approval by the Department using the following hierarchy:

- A QL for the specific constituent as reported in the most appropriate/sensitive actual published method, or from a study conducted by the agency that developed the method.
- A QL derived from a scientifically supported study by a state, county or municipal environmental regulatory agency.
- A QL derived from a MDL study by a LELAP certified laboratory. The study must follow all applicable EPA MDL determination guidance, be for the most appropriate/sensitive method, and have all laboratory research included in the request.

D. Identification of the AOI/Land Use

1. If contamination migrates from an industrial site to a residential site, should the site be evaluated as an industrial site or a non-industrial site?

If the future site use is to remain industrial, then industrial standards apply onsite. Residential standards apply to impacted media offsite where land use is residential. If the future land use is unknown at the site,

it should be conservatively assumed to be residential since the site is adjacent to residential property. If contamination migrates from an industrial site to a residential area, then 2 AOIs should be identified: an industrial AOI and a residential AOI.

2. If an AOI consists of a commercial facility and mobile home trailer, should land use be assumed to be industrial or non-industrial?

If a residence is located within the AOI, the land use must be assumed to be non-industrial (residential).

3. How should the AOI for a MO-3 assessment be identified if the area of impacted soil is greater than 0.5 acre and therefore the AOC does not meet the criteria for management under the SO or MO-1?

If the AOC meets the criteria for management under the SO, then SS based on a site-specific area of impacted soil should be calculated following the guidelines in Appendix H. The limiting SS should be compared to the constituent concentrations detected at each sampling location. Each location that has a constituent concentration exceeding the limiting SS should be identified for inclusion in the AOI.

4. How should site-specific SS be calculated if the exact area of impacted soil is unknown?

The area of impacted soil should be estimated based on available data (or knowledge of the release) and the SS should be calculated based on the estimated area. The limiting SS should be compared to the constituent concentrations detected at each sampling location to determine the area of impacted soil. If all sampling locations have concentrations exceeding the SS, then the area of impacted soil should be re-estimated and SS re-calculated based on a revised estimated area of impacted soil. This process should be repeated until the area of impacted soil has been delineated.

5. How can an AOI be delineated if there are only 1 or 2 sampling locations that have a constituent concentration exceeding the limiting SS or RS?

If there are only 1 or 2 sampling locations that have a constituent concentration exceeding the limiting SS or RS, then an AOI cannot be delineated as described in Section 2.6.1. The options available to the Submitter include: 1) evaluate the AOC under a higher tier; 2) if appropriate, re-sample the area of concern (for example, if a significant amount of time has passed since the data were collected, it may be beneficial to re-sample the area to see if the concentration has declined with time; or if the Soil_{gw} is the limiting RS, it may be beneficial to evaluate the soil to groundwater pathway by collecting SPLP data; etc); or 3) remediate the area.

6. How should it be determined if one AOI or multiple AOI should be identified for an AOC?

How many AOI are appropriate for an AOC will be dependent on site-specific conditions such as the COC present, COC distribution, land use, and receptor activity patterns at the AOC. In general, 1 or 2 non-detect sampling locations within an AOC is not sufficient to divide the AOC into 2 AOI. If an AOC is characterized by 2 distinct areas of impact characterized by different chemicals and it is apparent that 2 separate releases have occurred, then the AOC should be divided into 2 AOI. If there are two distinct areas of impact that are clearly separated by a relatively large non-impacted area, then in general, 2 AOI rather than 1 AOI should be identified.

7. Can the MO-2 Soil_{esi} values be applied in some way to only the soils under or adjacent to the buildings? The soils near the buildings do not exceed the Soil_{esi} MO-2 RS values, but the soils farther away, with no overlying building, do exceed these values. Is it possible to separate the areas into two AOIs?

If only a portion of the impacted soil is located beneath the enclosed structure, then two AOI should be identified as described below:

- 1) An AOI should be identified for all impacted soil (including soil not under the enclosed structure and soil under the enclosed structure) as described in Section 2.6.1, the AOIC should be estimated as described in Section 2.8, and the limiting RS (the lower of the $Soil_i$ or $Soil_{ni}$, $Soil_{gw}$ and $Soil_{sat}$) should be compared to the AOIC; and
- 2) An $Soil_{es}$ AOI should be identified and should include the sampling locations beneath the enclosed structure (or nearest to the enclosed structure); the sampling locations on or within the boundaries of the $Soil_{es}$ AOI should be used to estimate the AOIC that is compared to the $Soil_{es}$ RS.

If the majority of the impacted soil is located beneath the enclosed structure, then the AOI should be identified as described in Section 2.6.1, the AOIC should be estimated as described in Section 2.8, and the limiting RS (the lower of the $Soil_i$ or $Soil_{ni}$, $Soil_{gw}$, $Soil_{sat}$, and $Soil_{es}$) should be compared to the AOIC.

8. How should the GW_{es} RS for groundwater impacted with volatile constituents below an enclosed space be applied at the AOI?

If only a portion of the groundwater plume is located beneath the enclosed structure, then the GW_{es} should be compared to the groundwater concentrations present beneath the enclosed structure and/or concentrations expected to migrate under the enclosed structure. It may be necessary to establish an additional POC for the groundwater to an enclosed structure pathway (refer to Section 2.11.4). If the entire plume is located beneath the enclosed structure, then a limiting RS (lower of the GW_1 , GW_2 or GW_3 , GW_{es} , and $Water_{sol}$) should be identified for application at the POC(s).

9. How should the AOI for soils with high dust emissions be delineated?

If only a portion of the impacted soil is associated with high dust emissions, then two AOI should be identified as described below:

- 1) An AOI should be identified for all impacted soil (soil not associated with high dust emissions and soil associated with high emissions) as described in Section 2.6.1, the AOIC should be estimated as described in Section 2.8, and the limiting RS (the lower of the $Soil_i$ or $Soil_{ni}$, $Soil_{gw}$ and $Soil_{sat}$) should be compared to the AOIC; and
- 2) A Soil-PEF AOI should be identified that includes the sampling locations associated with the area of high dust emissions; the sampling locations on and within the boundaries of the Soil-PEF AOI should be used to estimate the AOIC that is compared to the Soil-PEF RS.

If the majority of the impacted soil is associated with high fugitive dust emissions, then the AOI should be identified as described in Section 2.6.1, the AOIC should be estimated as described in Section 2.8, and the limiting RS (the lower of the $Soil_i$ -PEF or $Soil_{ni}$ -PEF, $Soil_{gw}$, and $Soil_{sat}$) should be compared to the AOIC.

10. How should the AOI be identified for remediation verification?

For remediation verification, the verification samples obtained within the boundaries of the original AOI shall be included in the calculation of the AOIC to demonstrate that residual constituent concentrations comply with the limiting RS. Refer to Section 2.19 for further guidance.

11. If the maximum detected concentration rather than the 95%UCL-AM is being used as the AOIC and the constituent concentrations are declining with depth and lateral distance, is it still necessary to define the vertical and horizontal extent of the impact?

Under the SO, vertical and horizontal delineation to the SS is not required if the most heavily impacted area has been sampled and the maximum concentration detected is less than the SS. Under MO-1, MO-2, and MO-3, vertical and horizontal delineation of the AOI is required as described in Section 2.6.1.

12. Can the SO screening standards be used to delineate the AOI for soil and groundwater when it has been determined that there is no discharge to a surface water body?

Yes. If the criteria for screening soil and groundwater under the SO (Section 3.1) are met, then the AOI may be delineated using the SS listed in Table 1.

E. Constituents of Concern (COC)

1. If a chemical detected at an area of investigation (AOI) is not listed in Tables 1 through 3 does it have to be evaluated under RECAP?

Yes. The list of constituents present in Tables 1 through 3 represent the constituents most frequently encountered at sites present in Louisiana. If a constituent present at an AOI is not listed in Tables 1 through 3, then a SS or MO-1 RS should be calculated using the guidelines presented in Appendix H.

2. For an AOI where petroleum hydrocarbons have been released, does RECAP require that impacted media be analyzed for both indicator compounds and total petroleum hydrocarbons (TPH)?

Yes. For petroleum hydrocarbon releases, both indicator compounds and total petroleum hydrocarbons (TPH) must be evaluated. Refer to Appendix D Table D-1 of the RECAP document for the indicator compounds and the TPH carbon ranges that must be evaluated under RECAP for different types of petroleum hydrocarbon releases.

3. Mineral-oil based dielectric fluid is not addressed in Appendix D. How should mineral oil-based dielectric be evaluated under RECAP?

The SS and MO-1 RS for aliphatics C₁₆-C_{>35} may be used to evaluate releases of mineral oil-based dielectric fluid to the environment. Under MO-2 and MO-3, a RfD of 2.0 mg/kg-d may be used to develop risk-based RS for mineral oil-based dielectric fluids in the range of C₁₆-C_{>35} and a RfD of 20.0 may be used to evaluate mineral-based dielectric fluid compounds C_{>35}. The RfD developed for the aliphatic C₁₆-C_{>35} fraction is based on toxicity studies with aliphatic hydrocarbon mixtures (mineral oils) that were very similar in composition (and thus, expected to be similar in toxicity) to the aliphatic hydrocarbons that comprise mineral oil-based dielectric fluid. In addition, it is expected that the fate and transport of these compounds are consistent with the fate and transport of aliphatics C₁₆-C_{>35} (*Total Petroleum Hydrocarbon Criteria Working Group Series Volume 4 Development of Fraction Specific Reference Doses and Reference Concentrations for Total Petroleum Hydrocarbons*, TPHCWG 1997; *Electric Power Research Institute Insulating Oil Characteristics Volume: 1 Characterization Results*, EPRI TR-106898-V1 4168, 9087, December 1996).

F. Exposure Assessment

1. Why is exposure duration not taken into account when calculating residential RECAP standards for soil for carcinogenic compounds?

For carcinogens, exposure duration is factored into the age-adjusted intake rate and therefore does not occur as a separate parameter in the SS and RS equations. For a residential receptor, the intake rate and body weight are assumed to change over the course of the exposure period, i.e., a child grows into an adult during the 30 year exposure period. One exposure level is assumed for ages 1 to 6 years and another is assumed for ages 7 to 31 years. Age-adjusted intake rates serve to average the two different exposure levels over the 30-year exposure duration. Therefore, the exposure duration has already been taken into account in the age adjusted intake rate and therefore, does not appear as a separate parameter

in the SS or RS equation. Note: Age-adjusted intake rates are used for the evaluation of carcinogens for residential receptors for the soil exposure pathways. This is due to the fact that children ages 1-6 have been shown to have a higher soil ingestion rate than other age groups and thus have been identified as a sensitive subpopulation for the soil ingestion pathway.

2. What sampling locations should be used to calculate the 95%UCL-AM?

All data points located on or within the boundaries of the AOI should be included in the calculation of the 95%UCL-AM concentration. Data points outside the boundaries of the AOI should be dropped from further consideration.

3. Why is the 95%UCL-AM frequently greater than the maximum concentration detected?

When the data set is small (less than 10 samples) or when there is a lot of variability in the data set (such as a large number of non-detects), the 95%UCL-AM will probably be greater than the maximum detected concentration. In general, a data set comprised of 20 to 30 samples provides a fairly consistent estimate of the mean. The larger the data set, the closer the 95%UCL-AM is to the arithmetic mean. If the 95%UCL-AM is greater than the maximum detected concentration, then the maximum concentration should be used as the AOIC.

4. How should the distribution of the data be determined for the calculation of the 95%UCL-AM?

The distribution of the data may be determined by plotting the data (concentration vs. number of observations) or by the use of a statistical method such as the Wilk Shiparo test (W-test). Most environmental data are lognormally distributed. If the dataset is found to be normally distributed, then it is possible that the most heavily impacted areas have not been adequately characterized/sampled. It should be noted that different statistical methods are used for different data distributions. For lognormal distributions, the H-Statistic should be used. For normally distributed data, the Student-t Statistic should be used. For additional information refer to *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992) or *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987).

5. The algorithm for MO-2 GW_{air} RS doesn't contain any terms that account for slab or foundation thickness the way GW_{es} does. Does the GW_{air} RS only apply to an AOI that does not have a low permeability cover like asphalt or concrete? Surely asphalt and concrete covers would retard the transmission of volatile compounds from groundwater to ambient air.

GW_{air} is the RS for inhalation exposure associated with volatile emissions from shallow groundwater to the ambient air. It does not consider ground surface coverings such as concrete or asphalt pads. A different equation would be required under MO-3 to evaluate inhalation exposure associated with volatile emissions from shallow groundwater to the ambient air if there was a covering over the ground surface. However, under RECAP, a nonpermanent ground covering, such as a concrete or asphalt covering, is not assumed to render future exposure pathways associated with impacted soil or groundwater to be incomplete. Therefore, under MO-2, the GW_{air} is applicable for evaluating volatile emissions from shallow groundwater to the ambient air even if a concrete or asphalt cover is over the area of impacted groundwater.

6. Why weren't the default values for the Johnson & Ettinger model updated to include the values that EPA presented in the November 2002 draft vapor intrusion guidance? Will any of these EPA guidance values be allowed to replace the default values currently presented in Appendix H of RECAP?

The proposed revisions to RECAP were submitted to the Regulatory Development Division for release for public comment before EPA released the Draft Indoor Air Vapor Intrusion Guidance. Since changes were not proposed to the Johnson & Ettinger model in the proposed revisions to RECAP, the new default values

recommended by EPA could not be incorporated into RECAP 2003. After reviewing the EPA guidance, the Department has determined that the EPA default values recommended in the draft guidance may be used under RECAP MO-3 if the default value(s) has been demonstrated to be representative of site conditions.

The following parameters are pre-approved for use under RECAP MO-3 in the Johnson & Ettinger model:

Parameter Definition Input Value

ER - Non-industrial enclosed structure air exchange rate	0.000069 l/sec
I_{Bni} - Non-industrial enclosed structure volume/infiltration area ratio	244 cm
FC - Areal fraction of cracks in foundation/walls	$0.00038 \text{ cm}^2/\text{crack}/\text{cm}^2 \text{ total area}$
NW _{crack} - Crack dust water-filled porosity	0%
I_{crack} - Enclosed structure foundation or wall thickness	10 cm

NOTES:

1. 1. THESE ARE THE ONLY RECAP DEFAULT VALUES THAT ARE PRE-APPROVED BY THE DEPARTMENT FOR USE AS SITE-SPECIFIC INPUTS IN THE J&E MODEL.

2. 2. THE VALUES ABOVE CAN NOT BE CHANGED TO ANOTHER VALUE OF THE LISTED RANGE IN THE EPA GUIDANCE NOR CAN ANY OF THESE SINGLE VALUES BE REPLACED WITH THE RECAP DEFAULT INPUT VALUES OR VISA VERSA TO RESULT IN A HIGHER CLEAN UP STANDARD.

3. 7. **To identify the limiting RS for groundwater, is the GW_{air} compared to GW₃ and Water_{sol} and the lowest of the values chosen? Where is the GW_{air} applied?**

If the zone to be protected is present at < 15' bgs, then the limiting GW RS would be the lower of the GW₁, GW₂, or GW₃, GW_{air} and Water_{sol}. The limiting groundwater RS should be met at the POC. The identification of more than one POC may be warranted based on site-specific conditions (refer to Section 2.11).

8. How does RECAP (if at all) account for short-term exposure for construction workers under a potential future exposure scenario?

The surface soil interval (ground surface to 15 ft bgs) addresses exposure during excavation activities (i.e., construction workers). When the AOIC within the surface soil interval meets the limiting RECAP standard for an industrial scenario, then the exposure level is acceptable for industrial workers exposed to soils present down to a depth of 15 ft bgs (i.e., workers exposed to the soil for 250 days/year for 25 years). Therefore, it can be concluded that the exposure level is also acceptable for construction workers exposed to the soil at an exposure frequency and duration that are generally much shorter than that of a full-time industrial worker. Note: The Department does not consider it appropriate to base site management decisions on a construction worker scenario because the resulting soil standards (and thus residual COC concentrations) are only protective of receptors that will be present at the site for a very limited period of time. The application of RS based on a construction worker scenario would result in limited future site use, and may even result in land being unsuitable for commerce. The construction worker scenario does not take into consideration future site use nor the fact that COC in deeper soil may be brought to the surface during construction activities which may result in future industrial workers being exposed to unacceptable COC concentrations. Protection of construction workers or other receptors engaged in excavation activities is achieved when the COC concentrations present in the surface soil interval meet the industrial limiting soil RS.

9. Can a SS or a MO-1 RS be re-calculated if an EPA default exposure parameter is updated?

No. The SS and MO-1 RS are regulation and therefore will remain in effect until these values are revised through a rule change. Under MO-2 and MO-3, an updated EPA default exposure parameter may be used to develop a MO-2 or MO-3 RS.

10. How should RS for sediment be developed under RECAP?

Sediment RS shall be developed under MO-3 and should be based on the type of concern associated with the chemicals present in the sediment. If recreational exposure to sediment is a concern, then RS based on the ingestion of sediment and dermal contact with sediment should be developed. The equation for the soil RS can be used in conjunction with the appropriate input parameters. Soil default parameters are frequently used in the absence of sediment parameters (RAGS-A). The EFH provides default values for the sediment-to-skin adherence factor (AF) (sediment adherence) and the EF for swimming. A default sediment ingestion rate is not available in the EFH: RAGS-A recommends that the soil ingestion rate be used for the sediment ingestion rate. If the concern is the bioaccumulation of organic chemicals by biota (and fish ingestion pathway) then the use of the Biota-Sediment Accumulation Factor (BSAF) approach is the recommended approach for developing a sediment RS. If another cross-media transfer is the concern, then this EF&T pathway should be addressed via modeling and the results used to establish a sediment RS.

11. There appears to be a conflict in RECAP. RECAP states that MO-1 and MO-2 cannot be used if impacted groundwater discharges to surface water because exposure pathways associated with surface water are not addressed under MO-1 and MO-2 yet the equations in Appendix H for GW₃ include surface water ingestion and fish ingestion.

The GW₃ equations presented in RECAP were obtained from *Human Health Numerical Criteria Derivations for Toxic Substances*, LDEQ, Office of Water Resources, June 23, 1994. The numerical criteria set forth by the surface water regulations address only 2 exposure pathways – the ingestion of surface water while swimming and the ingestion of fish. These criteria do not address all concerns that are required to be addressed under RECAP such as inhalation of volatiles from surface water, dermal contact with surface water, ingestion of aquatic species other than fish, exposure to sediment, prevention of cross-media transfer (sediment to biota), or protection of resource aesthetics. Furthermore, they do not address additivity associated with exposure to multiple COCs or exposure via multiple media or pathways. They also do not, and cannot, address site-specific issues associated with exposure and environmental fate and transport at impacted surface water bodies. Exposure and environmental fate and transport pathways at impacted surface water bodies can be very complex and are best evaluated on a site-specific basis. Furthermore, the objective of the GW₃ RS is to prevent the cross-media transfer of COC from groundwater to surface water.

12. Do all of the exposure pathways identified for soil under the SO, MO-1, and MO-2 have to be considered in an assessment of surface soils or can a potential pathway be eliminated if it does not actually exist at a site (i.e. existing concrete pavement eliminating the potential for soil ingestion, inhalation or dermal contact) and there is no foreseeable change in site usage as an industrial facility?

Exposure to surface soil that is present below concrete pavement must be evaluated under RECAP. Concrete pavement is considered by the Department to be a temporary structure, and as such, it is not considered to be a permanent barrier for preventing future exposure to constituents present in surface soils. Therefore, the presence of concrete pavement is not sufficient to eliminate the soil exposure pathways from consideration in the evaluation of the AOI. Site management decisions based on the premise that concrete pavement prevents exposure to constituents present in surface soil could result in the occurrence of properties that pose a risk to human health in the event of bankruptcy or transfer of the property to a party who is unable to finance future remedial activities. This would in effect remove the property from commerce which is not the intent of the RECAP regulation.

13. Under what scenarios is an impacted surface soil not considered an exposure medium?

In most cases LDEQ will not allow material above residential/industrial RS in the upper 15 feet of soil to remain in place. The Department is concerned that this would remove property from commerce and/or create concerns for future use of the property. In some cases this may be allowed when it can be demonstrated that there will be no exposure to the material (e.g. - nonvolatile constituents beneath a permanent structure such as an office building; refer to Section 2.1 for a definition of a permanent structure) and there is a sufficient financial assurance/commitment to ensure that the property will remain useable. Institutional controls would also be required to ensure that unacceptable exposure would not occur.

14. Are OSHA PEL considered acceptable ARAR for use under the RECAP?

The use of an occupational health standard may be considered under MO-3 of the RECAP in accordance with Section 2.14.2 if it is adequately demonstrated to the Department that the standard is applicable or relevant and appropriate to serve as the C_{ai} based on site-specific conditions. In general, the Department will consider the use of an occupational health standard in the evaluation of the $Soil_{es}$, GW_{es} , and GW_{air} pathways under MO-3 if the following conditions are met:

- ~.(1) Current and future land use is industrial (i.e., not commercial, residential, recreational, etc);
- ~.(2) The occupational health standard is represented by the lower of the available eight-hour time-weighted average occupational inhalation criteria (OSHA PEL or ACGIH TLV);
- ~.(3) The Submitter shall:
 - ~.(a) Provide documentation that OSHA regulations are fully implemented (OSHA controls including workplace or worker monitoring, training, employee awareness of hazards, medical surveillance, etc. are being observed) throughout the AOI;
 - ~.(b) Provide documentation that the OSHA controls specifically address the COC for the pathway of concern ($Soil_{es}$, GW_{es} , and/or GW_{air}) (i.e., the workers being exposed are informed about additional exposure associated with the COC and pathway of concern, trained for the COC, undergo medical surveillance for the COC, the workplace or the workers themselves are monitored for exposure to the COC, etc.) (for example, there is an EDC plume under the EDC unit where OSHA controls are already in place for EDC). If the COC for the pathway of
 - ~.concern is not specifically addressed by the OSHA controls (i.e., the workers are not aware they are being exposed to the COC, are not trained for the COC, do not undergo medical surveillance for the COC, the workplace or the workers themselves are not monitored for exposure to the COC, etc.) (for example, there is an TCE plume under the EDC unit), then the OSHA controls shall be revised to include the COC and documentation of this revision shall be provided to the Department;
 - ~.(c) Certify that the OSHA controls are followed at the AOI;
 - ~.(d) Demonstrate that non-industrial receptors are protected in accordance with RECAP;
 - ~.(e) Demonstrate that the AOI for the $Soil_{es}$ and/or GW_{es} pathway does not include an enclosed structure or a portion of an enclosed structure which serves as work space for employees or other receptors whose normal work activities are not associated with occupational exposure to chemical constituents (e.g., administration buildings) unless those employees are subject to the same worker protection programs described in (a) and (b), above, and such demonstration is certified pursuant to (c), above;
 - ~.(f) Demonstrate that the AOI for $Soil_{es}$ and/or GW_{es} does not include an enclosed structure or a portion of an enclosed structure that is used for non-industrial purposes (e.g., day care facility, military base housing unit, etc.);
- ~.(4) The final soil RS shall not exceed other applicable soil RS ($Soil_{GW}$ and $Soil_{sat}$); and
- ~.(5) The final groundwater RS shall not exceed other applicable RS [GW_1 , GW_2 or GW_3 RS (depending on the groundwater classification of the zone under investigation) and $Water_{soil}$].

In accordance with Section 2.14 of RECAP, compliance with the occupational health standard (ARAR) will typically be considered protective even if outside the acceptable risk range unless there are extenuating circumstances such as exposure to multiple constituents, exposure via multiple pathways, or exposure to

more than one medium. The use of any ARAR under RECAP is subject to Department approval.

For further information on the C_{ai} for the evaluation of the $Soil_{es}$, GW_{es} , and GW_{air} pathways, refer to Section H2.3 of Appendix H of RECAP.

15. When does the Department approve the use of site-specific exposure data under MO-3?

Site-specific inputs to the risk evaluation must be adequately documented, truly site-specific, and realistic; they may not be replaced with literature values that are simply more favorable. Site-specific values shall be representative of reasonable maximum exposure (RME) for site-specific receptor activity patterns at the AOI and must be appropriate for both the current and expected future use of the property to ensure that the proposed action is protective, long term and does not remove the property in question from commerce. It is not the intent of the RECAP regulation to allow pathway elimination or exposure assumptions that will render a property unsuitable for commerce and/or create a brownfield site.

16. Can FDA tolerance levels or action levels be used to define acceptable exposure levels in fish tissues (i.e., RS) under RECAP?

The intent of RECAP is to ensure that health risks for local receptors associated with the ingestion of fish/shellfish obtained from local water systems that have become impacted due to uncontrolled constituent releases are within acceptable limits. The application of FDA action levels or tolerances may not be adequately protective of sports fishermen in Louisiana. The FDA has the responsibility for the risk management of foods in interstate commerce whereas state agencies have the responsibility for protecting consumers of local fisheries products. FDA tolerance levels are developed on a national basis (national problems and patterns of consumption). FDA action levels and tolerances are not intended to protect certain local populations such as individuals whose consumption of fish from a given water body may exceed the national average. In general, national consumption levels on a national per capita basis are less than that of sports fishermen. Furthermore, FDA sets action levels and tolerances in fisheries products to balance health protection and minimize economic impacts on food producing and harvesting industries and thus are not strictly risk-based (*Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual*, EPA, 1989).

17. How is the Geometric Mean Calculated?

The geometric mean is calculated by the following equation:

$$GM = \sqrt[n]{Y_1 Y_2 Y_3 \dots Y_n} = (Y_1 Y_2 Y_3 \dots Y_n)^{\frac{1}{n}}$$

Example

Hydraulic conductivity values were obtained by slug tests on three groundwater monitoring wells at a site. The average hydraulic conductivity is determined from the geometric mean.

- $K_1 = 3.5E-05$ cm/sec
- $K_2 = 4.0E-05$ cm/sec
- $K_3 = 6.0E-06$ cm/sec Using the geometric mean equation:

$$GM = \sqrt[3]{(3.5E-05)(4.0E-05)(6.0E-06)} = 2.03E-05$$

K The average hydraulic conductivity is determined to be:
 $GM = 2.03E-05$ cm/sec

G. Toxicity Assessment

1. What if a toxicity value is not available for a constituent detected at the AOC?

If a toxicity value is not available in IRIS, HEAST, regional EPA publications, or ASTDR toxicological profiles, the options include:

1. 1. Develop a toxicity value using EPA methodology if adequate/appropriate data are available;
2. 2. Identify a surrogate toxicity value based on structure/activity relationships and/or targets/critical effects;
3. 3. Use route-to-route extrapolation; or
4. Evaluate the constituent qualitatively. Before proceeding with any of these options, the Department recommends that you contact the LDEQ Toxicological Services Division for guidance.

2. What toxicity value should be used if only total data are available for a COC (speciation data are not available)?

If speciation data are not available, the most conservative toxicity value should be used (i.e., it should be assumed that the COC is present at the AOI in its most toxic form). It may be beneficial to conduct additional sampling to determine the speciation of the COC at the AOI.

3. When a range of values is given for a slope factor instead of a single value, what value should be used?

A cancer slope factor range rather than a single slope factor value is presented in IRIS for benzene. New cancer slope factors were developed based on new information for benzene. These slope factors are presented in IRIS as a range. The set of risk estimates falling within this interval reflects both the inherent uncertainties in the risk assessment of benzene and the limitations of the epidemiological studies in determining dose-response and exposure data. EPA modeled the unit risk values for the carcinogenicity of benzene from epidemiological data on occupationally exposed humans. The unit risk is expressed as a range rather than a single value because in the case of this particular pollutant there is no scientific basis for choosing a single result from various model estimates. (See IRIS benzene CASRN 71-43-2 at www.epa.gov/iris/subst/0276.htm). EPA considers any value within the range scientifically defensible, but is recommending the use of the upper limit value to establish the upper bound of the average ambient concentration that should not be exceeded. Pending further guidance on the application of slope factor ranges, the LDEQ is using the single point slope factors previously issued in IRIS for benzene as these values tend to fall roughly in the middle of the current range of values presented in IRIS.

4. Can a SS or a MO-1 RS be re-calculated if an EPA toxicity value is updated?

No. The SS and MO-1 RS are regulation and therefore will remain in effect until these values are revised through a rule change. Under MO-2 and MO-3, an updated EPA toxicity value may be used to develop a MO-2 or MO-3 RS or calculate health risks under MO-3.

5. How should total TCDD be evaluated under RECAP if the 2,3,7,8-TCDD is non-detect?

A TEF of 0.01 should be applied to the total TCDD results. Refer to Appendix D for further guidance on the evaluation of polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF).

6. What are the RfDs for the TPH fractions based on?

The RfD_o for Aromatics C>8-C16 is based on the EPA oral RfDs for ethylbenzene, styrene, xylene,

isopropyl benzene, naphthalene, acenaphthalene, and biphenyl and an oral RfD developed from a toxicity study conducted on a mixture of naphthalenes/methylnaphthalenes.

The RfD_i for Aromatics C>8-C16 is based on the EPA RfCs for ethylbenzene, styrene, isopropyl benzene, naphthalene, and from a toxicity study conducted on a mixture of C9 aromatics.

The RfD_o for Aromatics C>16-C35 is based on the RfD_o for pyrene.

The RfD_o and RfD_i for Aliphatics C>6-C8 are based on toxicity data for commercial hexane (solvent containing hexane isomers).

The RfD_o and RfD_i for Aliphatics C>8-C16 are based on toxicity data for JP-8 (C9-C16) and dearomatized petroleum streams C10-C11 and C7-C11.

The RfD_o for aliphatics C>16-C35 is based on toxicity data for mineral oils.

The RfDs for the TPH fractions were obtained from *Total Petroleum Hydrocarbon Criteria Working Group Series Volume 4 Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH)*, 1997.

7. EPA toxicity values are not available for the dermal route of exposure. RAGS-A states that the oral toxicity values may be used to evaluate the dermal route but that the oral values must first be adjusted to represent absorbed doses. For the evaluation of dermal contact with soil, when is this adjustment necessary?

Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) EPA 2001 (RAGS-E) states that the oral toxicity value should be adjusted to an absorbed dose IF the gastrointestinal absorption efficiency of the constituent is less than 50%. Since the gastrointestinal absorption efficiency of organic constituents (and select inorganic constituents) is greater than 50%, it is only necessary to adjust the oral toxicity value for certain inorganic constituents (refer to Exhibit 4-1 of RAGS-E). Another factor for consideration when evaluating dermal contact with soil is that the dermal absorption factor (ABS) for inorganic constituents (with the exception of arsenic and cadmium) is zero, i.e., dermal exposure is negligible and thus not quantitated thereby eliminating the need for dermal toxicity values for these constituents. Therefore, when the gastrointestinal absorption efficiency information for inorganic constituents presented in Exhibit 4-1 is cross-referenced with the dermal absorption factors in Exhibit 3-4 only one inorganic constituent – cadmium – is identified as requiring adjustment of the oral toxicity value for evaluation of the dermal route.

H. Additivity

1. What target organ should be used for lead to adjust the Soil_i and Soil_{ni} RS for lead to account for additivity?

Based on lead's mechanism of toxicity, EPA considers it inappropriate to develop a RfD for lead. Therefore, EPA has not identified a target organ/critical effect for lead. The Soil_i and Soil_{ni} values were developed using toxicokinetic models based on acceptable blood lead levels in sensitive industrial receptors and children, respectively. Consequently, it is not possible to include lead when adjusting for additivity as described under MO-1 and MO-2. In some site-specific situations that may arise under MO-3, it may be necessary to account for potential additive effects of lead with other COCs.

2. How should the TPH cap of 10,000 ppm be addressed when accounting for additivity?

The aesthetic cap of 10,000 ppm is not based on risk and therefore should not be adjusted to account for additive health effects. To account for additivity for the TPH fractions having a Soil_i or Soil_{ni} listed as 10,000 ppm in Table 2, refer to the worksheets at the end of Appendix H and obtain the risk-based Soil_i or Soil_{ni} value. Then refer to Appendix D to obtain the target organs for the TPH fractions. Adjust the risk-based value as discussed in Appendix G. If the adjusted value is less than 10,000 ppm, then the

adjusted risk-based value shall be used as the $Soil_i$ or $Soil_{ni}$. If the adjusted value is greater than 10,000 ppm, then 10,000 ppm shall be used as the $Soil_i$ or $Soil_{ni}$.

3. What are the target organs for TPH-G, TPH-D, and TPH-O?

The target organs/critical effects for TPH-GRO and TPH-DRO include the kidney, liver, hematological system, and decreased body weight. The target organs/critical effects for TPH-ORO include the liver and kidney.

4. When accounting for additivity for the TPH fractions, should each fraction be treated as an individual COC?

Although it is not incorrect to treat each TPH fraction as an individual COC when accounting for additivity, it may be overly conservative in some situations. The RfD of 0.1 mg/kg-d represents the acceptable daily intake for a mixture of aliphatic hydrocarbons ranging from C>8 to C16. Therefore additivity for the aliphatic C>8-C10, C>10-C12, and C>12-16 fractions was inherently accounted for during the toxicity testing and RfD development for these fractions. The same is true for the aromatic fractions C>8-C10, C>10-12, and C>12-C16. When accounting for additivity for the TPH fractions, the following fractions should be treated as individual COCs:

- . • Aliphatics C>6-C8
- . • Aliphatics C>8-C16
- . • Aliphatics C>16-C35
- . • Aromatics C>8-C16
- . • Aromatics C>16-35

Example: Soil impacted with ethylbenzene, aliphatics C>8-C10, C>10-C12, C>12-C16

1) Identification of target organs/critical effects:

ethylbenzene: liver, kidney, developmental
 aliphatics C>8-C10: liver, hematological system
 aliphatics C>10-C12: liver, hematological system
 aliphatics C>12-C16: liver, hematological system

2) Additivity - Liver: ethylbenzene and aliphatics C>8-C16

3) Adjustment factor: 2 NOT 4

4) Adjustment of MO-1 $Soil_{ni}$:

ethylbenzene: $1500/2 = 750$ mg/kg
 aliphatics C>8-C10: $1100/2 = 550$ mg/kg
 aliphatics C>10-C12: $2100/2 = 1050$ mg/kg
 aliphatics C>12-C16: $3100/2 = 1550$ mg/kg

5. When identifying the target organ/critical effect to account for additivity, is it necessary to identify the targets for both the oral RfD and the RfC (inhalation RfD)?

If exposure is possible by both routes of exposure (ingestion and inhalation), then yes, target organs/critical effects should be identified and included when accounting for additivity for both the oral RfD and the inhalation RfD.

6. If many COCs are present at an AOI, is it possible that the noncarcinogenic RS for $Soil_i$ or $Soil_{ni}$ may be lower than the carcinogenic RS for $Soil_i$ or $Soil_{ni}$?

Yes. If many COCs are present, the noncarcinogenic RS should be adjusted to account for additivity then compared to the carcinogenic RS. The lower of the adjusted noncarcinogenic RS and the carcinogenic RS should be identified as the $Soil_i$ or $Soil_{ni}$. For MO-1 assessments, the noncarcinogenic RS may be obtained from the worksheets presented at the end of Appendix H.

7. If the MCL serves as the GW_1 or GW_2 RS for a COC and there is no exposure to the groundwater, should the COC be accounted for when adjusting the RS for the remainder of the COCs?

Yes. The target organ/critical effect should be identified for all COCs which are associated with noncarcinogenic health effects. However, only the risk-based RS should be adjusted to account for additivity. RS based on the MCL should not be adjusted unless there is actual exposure to the groundwater (i.e., the groundwater is being used as a drinking water source).

8. How do I determine which target organ/critical effect should be identified for a COC when accounting for additivity?

The critical effect listed as the basis for the RfD and/or RfC is the critical effect that should be identified for the purpose of accounting for additivity. The target organ/critical effect should be obtained from IRIS (EPA). If the COC is not listed in IRIS, then HEAST (Health Effects Assessment Summary Tables, EPA) should be used. The target/critical effect for each route of exposure should be identified if available.

9. What if a constituent is listed in Tables 2 and 3 of RECAP but a RfD and/or a RfC and target organ/critical effect are not listed in IRIS or HEAST? What reference should be used to identify the target organ/critical effect?

Some of the toxicity values listed in RECAP were issued as provisional values by the EPA NCEA. Unfortunately, target organ/critical effect information is not available from EPA for provisional RfDs. Therefore, a COC that has a RS based on a provisional RfD may be excluded when accounting for additive health effects (i.e., the RS does not have to be adjusted to account for additive effects). Provisional toxicity values that were used to develop RS are footnoted with "E" in Table H-1 of Appendix H of RECAP.

10. When should additivity due to exposure to chemicals from multiple AOIs be addressed?

If the AOIs are directly adjacent to one another, then the adjustment of RS to account for additivity should probably address exposure to COCs present at both AOIs. If 2 (or more) AOIs are not adjacent to one another but a receptor is exposed to chemicals present at both AOIs during the exposure period, then the adjustment of RS to account for additivity should address exposure to COCs present at both AOIs. If a COC may migrate from one AOI to another (e.g. volatile emissions from soil to ambient air), then the adjustment of RS to account for additivity should address exposure to COCs present at both AOIs.

11. There appears to be a difference between MO-1 and MO-2 related to additivity but the difference isn't clear. RECAP states that "The MO-1 soil RS address exposure to a COC via a single medium" however the $Soil_i$ and $Soil_{ni}$ equations in Appendix H show how MO-1 RS were developed for multi-media exposures.

The $Soil_i$ and $Soil_{ni}$ equations in Appendix H are for the development of a RS for exposure to one chemical present in the soil (it also accounts for exposure to volatile emissions released from soil to the ambient air). These equations do not consider multi-media exposure. For example, the $Soil_{ni}$ and $Soil_i$ equations account for exposure to a single COC via three pathways - ingestion of soil, inhalation of emissions from soil, and dermal contact with soil. Thus, this equation addresses additivity associated with exposure to a single COC via multiple pathways for a single medium but does not address additivity associated with exposure to multiple COCs or exposure to the COC via multiple media (e.g., soil and groundwater). Under MO-1, additivity associated with exposure to multiple COCs may be addressed by grouping the COCs by target organ and then dividing the RS by the number in each group. Under MO-2, additivity associated with exposure to multiple COCs may be addressed 3 ways: 1) Group COCs by target organ and divide the RS by the number in each group; 2) Group COCs by target organ and apportion the target hazard index or RS

based on site-specific considerations; or 3) Calculate a total hazard index for each target organ to demonstrate that the total hazard index is less than or equal to 1.0. Additivity associated with exposure via multiple media may be addressed by adjusting the RS to account for additive effects - this may be done by dividing by the number of exposure media (MO-1, MO-2, and MO-3) or may be based on site-specific considerations (MO-2 and MO-3). Refer to Appendix G for further guidance on addressing additivity of health effects.

12. How is site-specific apportionment used to adjust RECAP Standards to account for additive noncarcinogenic health effects?

The target hazard quotients (THQ) for COC having the same target organ/critical effect may be apportioned in any manner the Submitter wishes as long as the total target index is equal to 1.0. For example:

Case Study: Xylene (56 mg/kg), naphthalene (3 mg/kg), TPH-GRO (3,043 mg/kg), and TPH-DRO (1,470 mg/kg) were detected in the soil at an industrial/commercial AOI.

Step 1: Identify the target organs/critical effects for each COC using IRIS and Appendix D of RECAP.

Xylene: decreased body weight, central nervous system (CNS), decreased longevity

Naphthalene: decreased body weight, nasal cavity effects

TPH-GRO: decreased body weight, kidney, liver, hematological system

TPH-DRO: decreased body weight, kidney, liver, hematological system

Step 2: Summarize by target organ/critical effect:

Decreased body weight (4): xylene, naphthalene, TPH-GRO, TPH-DRO

Liver (2): TPH-GRO, TPH-DRO

Kidney (2): TPH-GRO, TPH-DRO

Hematological system (2): TPH-GRO, TPH-DRO

CNS (1): xylene

Decreased longevity (1): xylene

Nasal cavity (1): naphthalene

Step 3: Adjust the RECAP Standards. The target hazard quotients for the calculation of the Soil for xylene, naphthalene, TPH-GRO, and TPH-DRO must be adjusted to account for the additive effect of decreased body weight. (by accounting for additivity for decreased body weight, additivity for the liver, kidney, and hematological system are also addressed). This can be done by equal apportionment of the target hazard quotients between COC (Example A) or by site-specific apportionment of the target hazard quotients between COC (Example B).

EXAMPLE A:

Equal apportionment of the target hazard quotients between COC:

COC	Soil _i	Target Hazard Quotient ^a	Adjusted Soil _i
Xylene	1200	0.25	300
Naphthalene	430	0.25	108
TPH-GRO	5100	0.25	1275
TPH-DRO	5100	0.25	1275
		Total Hazard Index = 1.0 ^b	

^a Multiplying by a hazard quotient of 0.25 is the equivalent of dividing by 4.

^b The sum of the four individual hazard quotients is equal to a hazard index of 1.0 for decreased body weight.

Comparison of RS to AOIC:

COC	Soil _i	AOIC	AOIC exceeds Soil _i ?
Xylene	300	56	No
Naphthalene	108	3	No
TPH-GRO	1275	3043	Yes
TPH-DRO	1275	1470	Yes

EXAMPLE B:

Site-specific apportionment of the target hazard quotients:

COC	Soil _i	Site-Specific Target Hazard Quotient	Adjusted Soil _i
Xylene	1200	0.05	60
Naphthalene	430	0.05	22
TPH-GRO	5100	0.6	3060
TPH-DRO	5100	0.3	1530
		Total Hazard Index = 1.0 ^a	

^a The sum of the four individual hazard quotients is equal to a total hazard index of 1.0 for decreased bodyweight.

Comparison of Site-Specific RS to AOIC:

COC	Soil _i	AOIC	AOIC exceeds Soil _i ?
Xylene	60	56	No
Naphthalene	22	3	No
TPH-GRO	3060	3043	No
TPH-DRO	1530	1470	No

13. How is site-specific apportionment used to adjust RECAP Standards to account for exposure to more than one impacted medium?

The target hazard quotients (THQ) may be apportioned between media in any manner the Submitter wishes as long as the total target index is equal to 1.0. For example:

Case Study: TPH-GRO was detected in the soil (550 mg/kg) of a number of backyards in a small residential community adjacent to a UST. TPH-GRO was also detected in the groundwater (0.05 mg/l) that serves as a drinking water source for the residents of this area (GW₁).

The RECAP Standards for soil (Soil_i) and groundwater (GW₁) must be adjusted to account for additive exposure resulting from simultaneous exposure to two impacted media. This can be done by equal apportionment of the target hazard quotients between soil and groundwater (Example A) or by site-specific apportionment of the target hazard quotients between soil and groundwater (Example B).

EXAMPLE A:

Equal apportionment of the target hazard quotients between soil and groundwater:

RECAP Standard		Target Hazard Quotient ^a	Adjusted RECAP Standard
Soil _i	650 mg/kg	0.5	325 mg/kg
GW ₁	0.34 mg/l	0.5	0.17 mg/kg
		Total Hazard Index = 1.0 ^b	

^a Multiplying by a hazard quotient of 0.5 is the equivalent of dividing by 2.

^b The total hazard index for exposure to TPH-GRO via soil and groundwater is 1.0.

Comparison of the RS and the AOIC and CC:

RECAP Standard		AOIC for Soil	CC for Groundwater	AOIC exceeds RS?
Soil _i	325 mg/kg	550 mg/kg	---	Yes
GW ₁	0.17 mg/kg	---	0.05	No

EXAMPLE B:

Site-specific apportionment of the target hazard quotients:

RECAP Standard		Site-Specific Target Hazard Quotient	Adjusted RECAP Standard
Soil _i	650 mg/kg	0.85	553 mg/kg
GW ₁	0.34 mg/l	0.15	0.051 mg/kg
		Total Hazard Index = 1.0 ^a	

^a The total hazard index for exposure to TPH-GRO via soil and groundwater is 1.0.

Comparison of the Site-Specific RS and the AOIC and CC:

RECAP Standard		AOIC for Soil	CC for Groundwater	AOIC exceeds RS?
Soil _i	553 mg/kg	550 mg/kg	---	No
GW ₁	0.051 mg/kg	---	0.05	No

I. Management Option 1

1. Can an AOI be managed under MO-1 if the areal extent of the groundwater plume is greater than 0.5 acres but the areal extent of the impacted soil is less than 0.5 acre?

Yes. If the area of soil contamination is less than or equal to 0.5 acre and the other criteria for management under MO-1 are met, then the AOI may be managed under MO-1.

J. Management Option 2

1. Can an area of investigation (AOI) with an areal extent of impacted soil larger than 0.5 acres be evaluated under Management Option 2?

Yes if the AOI meets the criteria for management under MO-2. Management Option 2 allows for the incorporation of site-specific environmental fate and transport data in the development of MO-2 RS. For sites with an area of impacted soil that is greater than 0.5 acre, the Soil_i and Soil_{ni} must be recalculated using a site-specific volatilization factor that is based on the size of the source (Q/C). In addition, a site-specific dilution and attenuation factor must be calculated based on site size (Sw in the Domenico model).

K. Ecological

1. Is it required under RECAP that an ecological checklist be included in each RECAP submittal?

Yes, the ecological checklist contained in Appendix C of the RECAP regulations must be completed and included with every RECAP submittal.

L. SoilGW / SPLP

1. How does the use of SPLP fit into the identification of the limiting RS?

If the SPLP is used to evaluate the soil to groundwater pathway, then the SoilGW RS is not included in the identification of the limiting RS. The lower of the remaining applicable RS is identified (Soil_i or Soil_{ni} and Soilsat) as the limiting RS.

2. Can TCLP data be used to evaluate the soil to groundwater pathway?

Yes.

3. Soil samples were collected from the most heavily impacted area of the AOI and submitted for the SPLP analysis. The results were non-detect (ND). Does the soil to groundwater pathway still need to be addressed in any way?

If the SPLP results are non-detect and the quantitation limit for the SPLP analysis is less than the GW RS x DF, then the soil to groundwater pathway may be eliminated from further consideration.

4. If groundwater is not impacted (i.e., reported groundwater concentrations are below detection), does the soil to groundwater pathway still need to be evaluated?

Yes, the soil to groundwater pathway must still be evaluated even if the groundwater has not been impacted. The SoilGW RS represents a soil concentration that does not result in the leaching of an unacceptable constituent concentration from soil to groundwater and is based on the protection of groundwater from potential future impact.

5. What is SPLP and how is it compared to RECAP standards?

SPLP is the acronym for Synthetic Precipitation Leaching Procedure, EPA SW-846 Method 1312. This test is used to determine potential leaching or mobility of organic and inorganic analytes present in liquids, soils, and wastes. The test can be specific for volatiles, semi-volatiles, metals, or pesticides and herbicides.

The SPLP test result may be used to determine if a constituent's concentration in soil is protective of groundwater as presented below.

For the protection of groundwater meeting the definitions of Groundwater Classifications 1, 2 and 3 under the Screening Option:

Compare the SPLP results to the $GW1 * DFSummers$:

If the SPLP results are less than or equal to the $GW1 * DFSummers$, then the COC concentration in the soil is protective of groundwater. Therefore, this pathway is eliminated from further consideration.

If the SPLP results are greater than the $GW1 * DFSummers$, then the COC concentration in the soil is not protective of groundwater and further evaluation or corrective action is required.

Note: The GW1 values may be obtained from Table 3; $DFSummers = 20$.

For the protection of groundwater meeting the definition of Groundwater Classification 1 under MO-1, MO-2, or MO-3:

Compare the SPLP results to the $GW1 * DFSummers$:

If the SPLP results are less than or equal to the $GW1 * DFSummers$, then the COC concentration in the soil is protective of groundwater. Therefore, this pathway is eliminated from further consideration.

If the SPLP results are greater than the $GW1 * DFSummers$, then the COC concentration in the soil is not protective of groundwater and further evaluation or corrective action is required.

For the protection of groundwater meeting the definition of Groundwater Classification 2 under MO-1, MO-2, or MO-3:

Compare the SPLP results to the $GW2 * DFSummers * DF2$:

If the SPLP results are less than or equal to the $GW2 * DFSummers * DF2$, then the COC concentration in the soil is protective of groundwater. Therefore, this pathway is eliminated from further consideration.

If the SPLP results are greater than the $GW2 * DFSummers * DF2$, then the COC concentration in the soil is not protective of groundwater and further evaluation or corrective action is required.

For the protection of groundwater meeting the definition of Groundwater Classification 3 under MO-1, MO-2, or MO-3:

Compare the SPLP results to appropriate $GW3 * DFSummers * DF3$:

If the SPLP results are less than or equal to the $GW3DW$ or $GW3NDW * DFSummers * DF3$, then the COC concentration in the soil is protective of groundwater. Therefore, this pathway is eliminated from further consideration.

If the SPLP results are greater than the $GW3DW$ or $GW3NDW * DFSummers * DF3$, then the COC concentration in the soil is not protective of groundwater and further evaluation or corrective action is required.

Note: The GW RS may be obtained from Table 3; DFSummers = 20; DF2 and DF3 values may be obtained from Appendix H for MO-1 and site-specific DAF2 and DAF3 values may be developed under MO-2 using the guidelines in Appendix H.

M. Soilsat

1. It appears in the worksheets in Appendix H (MO-1) that the Soilsat RS was not included in the identification of the limiting soil RS for TPH-G, TPH-D and TPH-O. Why not?

The Soilsat RS values calculated for TPH-GRO, TPH-DRO, TPH-ORO, the TPH aliphatic fractions and the TPH aromatic fractions using the physical/chemical data developed by the TPHCWG and the Soilsat algorithm presented in Appendix H are orders of magnitude lower than the Soilsat values for key individual constituents known to be contained within these mixtures. Based on this finding, the Department concluded that the Soilsat values are not truly representative of when soil saturation may be reached for TPH mixtures, and therefore, it was inappropriate to apply the Soilsat RS to assess TPH-impacted soils.

N. Identification of the Limiting Groundwater RS

1. If a $GW3DW$ or $GW3NDW$ is less than the $GW2$, can the $GW2$ be applied to a Groundwater 3 zone?

The Submitter may apply the $GW2$ RS to a Groundwater 3 zone if the $GW3$ RS (after multiplying by the $DF3$) is less than the $GW2$ RS (before multiplying by the $DF2$). The $GW2$ RS shall be multiplied by a $DF2$ not a $DF3$ (i.e., account for migration from the point of compliance to the downgradient property boundary).

2. RECAP states that if the $GW3$ (after applying the $DF3$) is less than the $GW2$, then the aquifer to be protected shall be managed as an aquifer meeting the definition of Groundwater Classification 2 and the $GW2$ shall be identified as the GW RS. Does this apply only to the COC for which the $GW3$ is less than the $GW2$ or does it apply to all of the groundwater COCs?

It applies only to those COCs for which the $GW3$ (after applying the $DF3$) is less than the $GW2$. For those COCs, the aquifer shall be managed as a Groundwater 2 aquifer. For the remaining COCs, the aquifer shall be managed as a Groundwater 3 aquifer.

O. Groundwater 3

1. If a contaminant plume is not currently discharging to a surface water body, but there is the

potential that the plume could discharge into the water body in the future (the groundwater travel time for the plume to reach the water body is greater than 2 years), does the groundwater have to be evaluated under MO-3?

If the plume is contained and COCs are not allowed to reach the surface water body, then no, the site does not need to be managed under MO-3. If the plume is not contained and COCs are allowed to migrate to the surface water body, then yes, impacts to the surface water body must be addressed under MO-3. Site management decisions should be made to prevent plume migration and to prevent impacts to the water body.

2. There appears to be a policy conflict in RECAP. RECAP states that MO-1 and MO-2 cannot be used at an AOI where constituents are discharging to surface water via groundwater yet the GW3 RS and DF3/DAF3 are based on the migration of constituents from the source to the nearest downgradient surface water body.

No, there is not a conflict. First, no discharge of COCs via groundwater is allowed under RECAP. The GW3 RS is a numerical standard based on the potential discharge of a COC to a downgradient surface water body. The objective of the GW3 RS is to prevent the cross-media transfer of a COC from groundwater to surface water (it is based on preventing a COC from reaching the surface water body at concentrations that exceed the surface water human health numerical criteria as set forth by regulation under the assumption of no action at the AOI). The GW3 RS is based on the potential release of a COC to surface water via groundwater - it is not the intent of the GW3 RS to allow an actual release to surface water via groundwater discharge.

3. Does the Department have preferred methods for evaluation of slug test data and calculation of well yield and if so, what are they?

Appendix F of the RECAP document provides guidance for the estimation of well yield utilizing data collected from properly conducted slug tests. There are a number of software programs available for evaluating this slug test data. Table F-2 in Appendix F lists references of some of the conceptual slug test models. By making some assumptions to the conceptual slug test models, well yield can be estimated. For example, the results of the slug test analysis can be incorporated in the Cooper and Jacobs approximation to the Theis solution to estimate well yield utilizing the following assumptions and equations:

Estimation of Well Yield

Reference:

Driscoll, F.G., *Groundwater and Wells*, 1986, 2nd ed., Johnson Division, St. Paul, Minnesota.

The estimated well yield equations are derived from the Cooper and Jacob (1946) modification to the Theis (1935) nonequilibrium well equation. The Cooper and Jacob modification using English engineering units is given as:

$$s = \frac{264Q}{T} \log_{10} \frac{3.0 t T}{r^2 S}$$

where:

s = drawdown at a distance (r) from the pumping well, feet Q = yield from pumping well, gpm T = transmissivity, gpd/ft t = time of pumping, days r = distance from pumping well to observation well where drawdown is measured, feet S = storativity, dimensionless

The estimated well yield equations are derived using some assumptions and logarithmic functions. The estimated well yield equations and assumptions are given as:

Confined Aquifer Unconfined Aquifer

$$Q = \frac{60 b K h}{3.9 + \log(b K)} \quad Q = \frac{16 b K^2}{3.6 + \log(b K)}$$

where:

Q = estimated well yield, gpm
 hc = confining head above the upper stratigraphic boundary of the aquifer, feet

K = hydraulic conductivity of the aquifer media, cm/sec

b = saturated aquifer thickness, feet

Assumptions: s = 0.75 hc feet (confined aquifer)

s = 0.2 b feet (unconfined aquifer)

t = 7 days

r = 0.5 feet

S = 1.0E-04 (confined)

S = 1.0E-01 (unconfined)

P. Groundwater POC

1. Does RECAP allow for/require the identification of more than one POC for groundwater?

Yes. The number of POC and placement of the POC will be dependent on site-specific conditions such as constituent distribution, groundwater flow direction, and potential points of discharge or POE. It may be necessary for Groundwater 2 and 3 zones to develop separate DFs or DAFs and RS for each POC depending on site-specific conditions. Refer to Section 2.11.

Q. Source

1. What is the definition of “source”? Is it an actual contaminant source or an impacted medium containing the contaminant or both?

Both. Residual constituent concentrations in an environmental medium may serve as a source of constituent transport and/or transfer to another environmental medium. However, it should be noted that RECAP is applicable to sites that are in a declining condition [i.e., the primary source (original source of contaminant release) has been removed or mitigated and the constituent mass is not increasing]. RECAP was not designed, or intended to be used to address sludges or other non-media sources. The objective of RECAP is to use risk evaluation to identify constituent levels in impacted media that do not pose unacceptable risks to human health or the environment.

R. Dilution Factors (DF) and Dilution and Attenuation Factors (DAF)

1. How should site-specific retardation and degradation values be established for the calculation of a DAF under MO-2?

Since the data required for the development of site-specific retardation and degradation factors are chemical-specific, process-specific, and of course site-specific, it is not possible to provide general guidelines or recommendations that are applicable to all sites. A literature review of the natural environmental fate and transport of the COC in question would provide important background information on determining what data may be useful in quantitating constituent retardation and degradation at the AOI. In general, data collected over time will be required, such as the reduction in chemical concentration over time and daughter product formation.

2. What concerns may the Department have if the site-specific DAF for a groundwater 2 or 3 zone is very large?

If a site-specific DAF is large thus allowing relatively high residual constituent concentrations to remain in a GW 3 zone at the site, the Department may require that additional exposure scenarios/pathways be evaluated such as a construction worker exposure to shallow groundwater and the migration of constituents to deeper groundwater zones.

3. If site-specific values are not available for the calculation of a site-specific DAF, can the default of 20 be multiplied by the site-specific Domenico to yield the site-specific DAF?

Yes.

4. Under MO-1, if the distance from the point of compliance (POC) to the point of exposure (POE) (the nearest downgradient surface water body or property boundary) is greater than 2000 feet, may the Submitter default to the dilution factor given for 2000 feet?

Yes, under MO-1 the Submitter may default to the dilution factor for 2000 feet to evaluate impact at a point of exposure greater than 2000 feet from the point of compliance.

5. How do you determine L, Sw, and Sd for calculating a DAF using the Domenico model?

Source length (L) and width (Sw) are defined by the contiguous area of impacted soil within the vadose zone having COC concentrations that exceed the limiting standard applicable for the option being implemented. The source length and width should be determined once the leak or spill has been stopped and/or the source removed. The following guidelines should be followed when evaluating the source length and width:

Screening Assessment Option- the limiting SS shall be used to identify source length and width

MO-1 Assessment Option- the limiting SS shall be used to identify source length and width

MO-2 and Appendix I Assessment Option- The limiting MO-1 RS shall be used to identify source length and width

MO-3 assessment Option- the limiting MO-2 RS shall be used to identify the source length and width

Example: At some point in time a UST was removed from service. A leak in the UST had developed and gone undetected during its service life. At a later date the UST was being removed from the ground and the contamination was found. As a result, the area was investigated (to distinguish from sampling during tank removal).

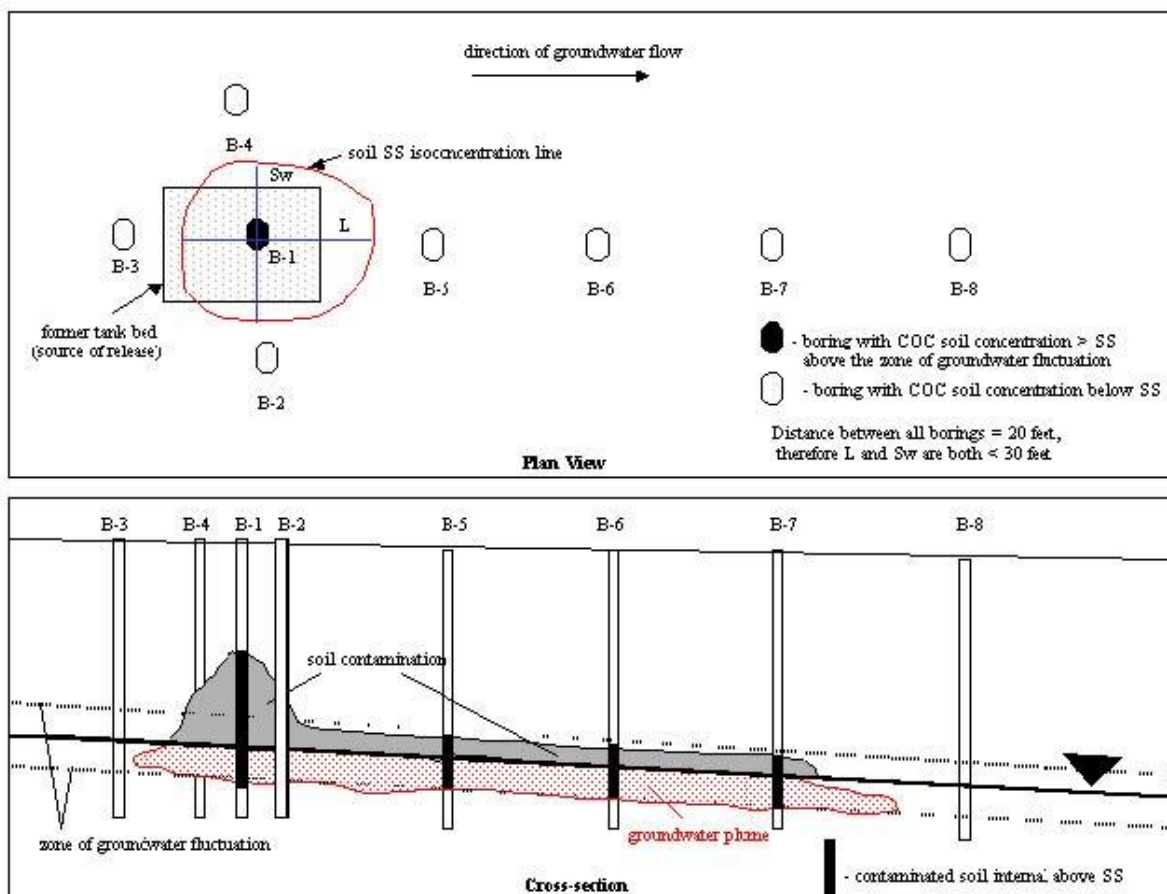
The first step in defining L and Sw is to plot the maximum soil analytical values from the investigation borings on a scale plan (top) view drawing of the site area. There should be enough boring points to enable the drawing of COC isoconcentration lines. Do not include analytical values from borings that only show contamination within the expected water table fluctuation zone. It is reasonable to say that contamination located only in the water table fluctuation zone was carried to that point by groundwater transport. Using the RECAP SS value, draw an isoconcentration line around the impacted site area. This is the outline of source area. Then draw in the groundwater flow direction.

L is defined as the longest length of the source area parallel to groundwater flow and Sw is the longest length of the source area perpendicular to groundwater flow. L times Sw equals the area of the source.

Sd is estimated at the downgradient L boundary of the source area. Sd is the estimated depth or thickness of the dissolved COC in the groundwater within the permeable zone. There are two methods in RECAP to estimate Sd. One method is to calculate Sd. The other is to use the thickness of the impacted permeable zone. When using Appendix I, a Site-Specific RECAP Evaluation for Typical UST Sites, Figure I-2, Appendix I Dilution Factors, associates Sd values with Sw and L values. The Sd value in the figure corresponding to the source area (L and Sw) determined in the investigation may be used unless investigation results indicate that a different Sd value should be considered. If L, Sw, and Sd yield different results for a dilution factor, the more conservative value should be used.



See the example drawing below.



6. When the source width (Sw) and the source length (L) for a UST source area are significantly different, should the lower or higher value be used to identify the correct dilution factor (Figure I-2) when conducting an Appendix I assessment?

The key to identifying the correct dilution factor is to select a Sw and L value that best represents the total square footage of the source area. For example, if a source area is defined by a Sw of 65 ft. and an L of 150 ft., the total square footage of the source area is $65 \text{ ft.} \times 150 \text{ ft.} = 9750 \text{ ft}^2$. By taking the square root of 9750 ft^2 , the source area is redefined by Sw and L values that are equal, $(9750 \text{ ft}^2)^{1/2} = 98.7 \text{ ft}$. Therefore, for this example, the most appropriate Sw and L value given in Figure I-2 would be 100 ft. which is equal to a total square footage of $10,000 \text{ ft}^2$.

S. Geotechnical Data

How Do I Use the Geotechnical Data in the RECAP Evaluation?

The geotechnical data provides some useful site-specific parameters that can be used in the RECAP evaluation. However, it is important to be consistent with the units and use only like units in the RECAP spreadsheet. These parameters can be input in the RECAP spreadsheet on the “Soil Properties & QC” tab.

Dry Soil Bulk Density (pb)

This parameter is typically provided on the geotechnical reports as Dry Density in units of lbs/ft³ (pcf); however, the RECAP units for this parameter are g/cm³. To convert from pcf to g/cm³, multiply pcf by 0.01602.

Example: $pb = (95.1 \text{ pcf}) \times (0.01602) = 1.52 \text{ g/cm}^3$

The 1.52 g/cm³ value can now be substituted for dry soil bulk density (pb).

Soil Particle Density (ps)

This parameter is typically provided on the geotechnical reports as the unitless Specific Gravity (Gs). Specific gravity is the ratio of the unit weight of the soil solid particles to the unit weight of water and is given by the following equation:

$$Gs = (pb) \div (1 - n)$$

Example: $Gs = (1.52 \text{ g/cm}^3) \div (1 - 0.426) = 2.65 \text{ g/cm}^3$

The 2.65 g/cm³ value can now be substituted for the soil particle density (ps). Also observe the specific gravity value provided in the geotechnical reports can often be directly substituted for the soil particle density without further conversion.

Total Soil Porosity (n)

This parameter may be provided on the geotechnical reports in units of percent (%) or in the decimal equivalent. The decimal equivalent is used in the RECAP spreadsheet. If the units are in percent (%), divide percent (%) porosity by 100 to convert to the decimal equivalent.

Example: $n = (42.6 \% \text{ porosity}) \div 100 = 0.426 \text{ Lpore/Lsoil}$

The 0.426 Lpore/Lsoil value can now be substituted for total soil porosity (n). Also observe that total soil porosity (%) is the ratio of the volume of the voids to the total volume and is given by the following equation that is calculated for you in the RECAP spreadsheet. Therefore, no additional substitution is necessary.

$$n = 1 - (pb \div ps)$$

Example: $n = 1 - (1.52 \text{ g/cm}^3 \div 2.65 \text{ g/cm}^3) = 0.426 \text{ Lpore/Lsoil}$

Water Filled Soil Porosity (nw)

This parameter may be provided on the geotechnical reports as Volumetric Moisture Content in decimal equivalent. Most commonly, the geotechnical reports provide percent (%) Moisture Content which is a gravimetric ratio of mass of water to mass of dry soil. The parameter used in the RECAP spreadsheet is the decimal equivalent of the volumetric moisture content which is a ratio of the volume of water to volume of soil and given by the following equation. Since the density of water (p_w) is 1 g/cm³, we can convert from gravimetric moisture content to volumetric moisture content by simply multiplying gravimetric moisture content by dry soil bulk density (p_b).

Example:

Gravimetric Moisture Content (MCG) = (26.4 % moisture content) ÷ 100
 $MCG = 0.264 \text{ g}_{\text{water}}/\text{g}_{\text{soil}}$

Volumetric Moisture Content (MCV) = $MCG \times (p_b \div p_w)$
 $MCV = (0.264) \times (1.52 \text{ g/cm}^3)$
 $MCV = 0.401 \text{ L}_{\text{water}}/\text{L}_{\text{soil}}$

The 0.401 L_{water}/L_{soil} value can now be substituted for water filled soil porosity (nw)

Air Filled Soil Porosity (na)

This parameter may be provided on the geotechnical reports as Volumetric Air Content in decimal equivalent. Most commonly, it is not provided on the geotechnical reports, but is given by the following equation of the total soil porosity (n) less the water filled soil porosity (nw). This calculation is provided for you in the RECAP spreadsheet; therefore, no additional substitution is necessary.

$n_a = n - n_w$

Example: $n_a = 0.426 \text{ L}_{\text{pore}}/\text{L}_{\text{soil}} - 0.401 \text{ L}_{\text{water}}/\text{L}_{\text{soil}} = 0.025 \text{ L}_{\text{air}}/\text{L}_{\text{soil}}$